PCT

WORLD INTELLECTUAL PROPERTY ORGANIZA
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification [4] **:**
B22D 11/10, 41/08

A1

(11) International Publication Number: WO 88/ 06500

(43) International Publication Date: 7 September 1988 (07.09.88)

(21) International Application Number: PCT/GB88/00139

(22) International Filing Date: 29 February 1988 (29.02.88)

(31) Priority Application Number: 8704764

(32) Priority Date: 28 February 1987 (28.02.87)

(33) Priority Country: GB

(71) Applicant *(for all designated States except US):* THOR CERAMICS LIMITED [GB/GB]; P.O. Box 3, Stanford Street, Clydebank, Dunbartonshire G81 1RW (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : LEE, Stephen, John [GB/GB]; 6 River View Crescent, Cardross G51 5LT (GB).

(74) Agent: FITZPATRICKS; 4 West Regent Street, Glasgow G2 1RS (GB).

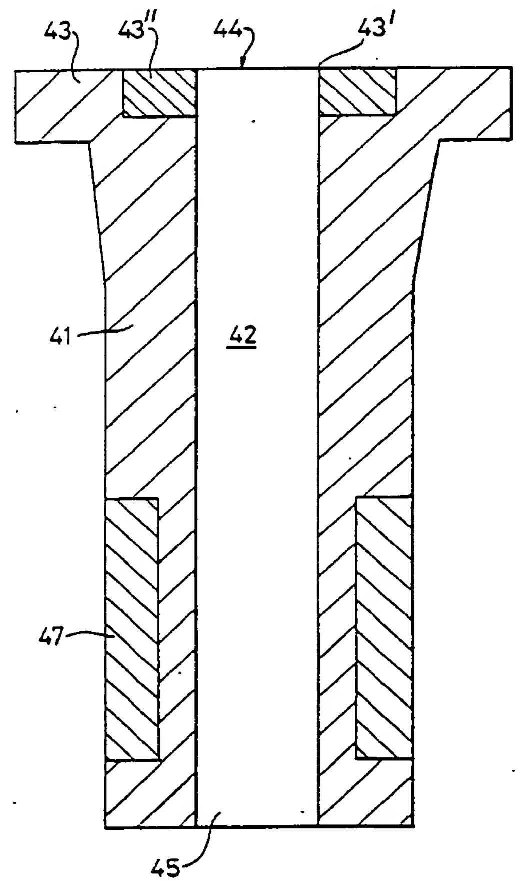
(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB, GB (European patent), IT (European patent), LU (European patent), NL (European patent), SE (European patent), US.

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: TUBULAR REFRACTORY PRODUCT

(57) Abstract

A refractory pouring-assembly component (1; 21; 31; 41) for use with a tube changer mechanism comprises an elongate tubular body having a throughbore (2; 22; 32; 42) for use with a tube changing mechanism to provide a replaceable means for pouring of molten metal during continuous casting from a tundish (19) into a mould wherein the refractory pouring component is an isostatically pressed, heat- and wear-resisting refractory one-piece composite body (1; 21; 31; 41) which is shaped to provide at one end a smooth, flat plate surface (3; 23; 33; 43) in which there is defined an aperture (4; 24; 34; 44), the peripheral edge (3'; 23'; 33'; 43') around said aperture being formed of a hard refractory material to provide an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the throughbore (2; 22; 32; 42) of the pouring assembly during pouring of molten metal therethrough, whilst the remainder of said body is formed to a tubular shape from a thermal shock-resistant material to provide for pouring of melt. The compositions of said component may be uniform blends of refractory material bonded by silicon nitride or silicon oxy-nitride or an annulus of selected hard materials within a graphite/alumina host body.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	ML	Mali
AU	Australia	GA	Gabon	MR	Mauritania
BB	Barbados	GB	United Kingdom	MW	Malawi
BE	Belgium	HU	Hungary	NL	Netherlands
BG	Bulgaria	IT	Italy	NO	Norway
BJ	Benin	JP	Japan	RO	Romania
BR	Brazil	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	LI	Liechtenstein	SN	Senegal
CH	Switzerland	LK	Sri Lanka	SU	Soviet Union
CM	Cameroon	LU	Luxembourg	TD	Chad
DE	Germany, Federal Republic of	MC	Monaco	TG	Togo
DK	Denmark	MG	Madagascar	US	United States of America
FI	Finland				

Tubular Refractory Product.

This invention relates to a refractory product for use in continuous casting. More particularly the invention is concerned with tubular refractory products for use in pouring of melt from the tundish to the mould. Flow of melt from the tundish into a mould is commonly controlled by raising or lowering of a refractory stopper rod from or to a seating position in the base of the tundish where there is located either a fixed sub-entry nozzle (SEN) or a tundish nozzle, built into the tundish base, onto which a sub entry shroud (SES) is fastened. In place of stopper rod valve closures, a slide gate control mechanism to which the SEN or SES is attached is also known.

Recently some steelmakers have been fitting to the underside of the tundish a fairly simple mechanism which enables quick changeover of such pouring tubes to minimise loss of time and production in replacing worn or damaged tubes. Such a tube-changer is described in GB 1 597 215 whilst another is disclosed in EP-A-0 192 019. When an SES is cracked or worn out the mechanism rapidly pushes out the used piece and drives a new tube into alignment underneath the metal stream, for example by means of a piston arrangement.

The present systems use an upper nozzle having a seating position to receive a flow control stopper located within a well block fixed into the tundish lining against which a stationary plate is fitted and incorporating a suitable jointing arrangement between the two components. A lower assembly is held in place against the underside of this stationary plate by the tube changer mechanism and comprises a moving plate and submerged pouring shroud jointed by a suitable arrangement and retained within a strengthening steel shell which serves to hold the two components firmly together and to withstand the pressures transmitted by the operating piston.

SUBSTITUTE SHEET

Whilst improvements have been made in the tube changing mechanisms since their introduction, there remain problems in ensuring adequate fitting of the respective mating surfaces of the tube, nozzle and upper or stationary plate and the lower or sliding plate of the tube changer and the submerged pouring shroud. If improper fitting of these refractory components occurs then air/oxygen leakage through the misfitting joints is possible with detrimental effect upon the quality of the steel. Air/oxygen penetrating the joints reacts with the alumina in the steel leading to build up of alumina deposits and clogging of the pouring tube. Such reaction also yields a problem manifesting itself as inclusions in the casting commonly identified as black spot.

Thus those in this field have hitherto sought to mitigate such problems by seeking to improve the tube handling and change-over systems leading to ever more complex and expensive handling systems.

An object of the present invention is to obviate or mitigate the aforementioned problems by providing improved pouring tubes suitable for use in conjunction with bottom pouring metallurgical vessels and existing tube changers thereby obviating the need for further development of the changer mechanisms.

Accordingly the present invention provides a refractory pouring-assembly component comprising an elongate tubular body having a throughbore for use with a tube changing mechanism to provide a replaceable means for pouring of molten metal during continuous casting from a tundish into a mould wherein the refractory pouring component is an isostatically pressed, heat- and wear-resisting refractory one-piece composite body which is shaped to provide at one end a smooth, flat plate surface in which there is defined an aperture, the peripheral edge around said aperture being formed of a hard refractory material to provide an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the

throughbore of the pouring assembly during pouring of molten metal therethrough, whilst the remainder of said body is formed to a tubular shape from a thermal shock-resistant material to provide for pouring of melt.

It is preferred that the said component is formed from silicon nitride-bonded or silicon oxy-nitride-bonded materials selected from alumina/graphite, zirconia/graphite, magnesia/graphite or appropriate mixtures thereof. In this way a single component having a substantially uniform composition meeting the defined use requirements can be made.

Alternatively a co-pressed configuration is possible whereby an annulus around the aperture in the flat plate surface is made from a material having the requisite strength, thermal shock resistance and physical compatibility with the remaining plate and SES body material. A specifically formulated Al_2O_3 SiO_2 ZiO_2 C material is suitable within an alumina graphite host body. This of course requires controlled packing of the isostatic-pressing mould in a manner known _per se_ using materials selected in accordance with this invention. The components of this material are usually such that the alumina exceeds about 45% by weight, silica and zirconia are in lesser amounts such that the zirconia may exceed the quantity of silica and still allow a small quantity of carbon to be included. Thus a desirable composition comprises 53% alumina, 18% silica, 24% zirconia and 3% carbon with the balance being minor amounts of typical materials used in this art. In this alternative arrangement it is not necessary to rely on silicon nitride or silicon-oxy-nitride bonding.

Thus this invention approaches the problem of imperfect seals with a new solution in that totally new refractory components are used in the pouring assembly. Each of the previously used sliding upper and lower plates of the tube changer system, the tundish bottom nozzle or block and the pouring tube is now replaced. In place of four components,

two components are provided by this invention. Thereby eliminating two of the troublesome joints in the pouring/changer assembly. If desired it is possible only to replace the lower plate of the tube changer and the conventional pouring tube with a composite tube/slide plate of this invention since this is the region normally most subject to wear and leakage caused by tube changing. Previously this would not have been contemplated due to the fundamentally different tasks of the respective components of the four piece assemblies. The plates of the tube changer have to be sufficiently hard as to be able to sever cleanly the frozen melt skin or shell formed during pouring of melt through the assembly whilst the pouring tube leading from the changer plates into the mould must be capable of withstanding thermal shocks. These requirements are generally considered to be opposing in that a material having suitable hardness characteristics is of generally poor resistance to thermal shock and vice versa. However it is now surprisingly found that is possible to make in a single step a refractory component having the requisite hardness and thermal shock resistant properties using the above-mentioned materials or the like.

As mentioned above the invention may be applied to the upper tube changer fixed plate/tundish block or nozzle parts of the pouring assembly or to the lower sliding plate/pouring tube parts of the pouring assembly. Best advantages are obtained with replacement of all known components with the new composite components of this invention.

The invention will now be further described with reference to the accompanying drawings in which :-

Fig. 1 is a section through a conventional lower slide plate of a tube changer;

Fig. 2 is a section through a conventional pouring tube adapted to mate with the lower slide plate shown in Fig.1;

SUBSTITUTE SHEET

Fig. 3 is a section through a pouring tube of this invention which replaces the components shown in Figs. 1 and 2;

Fig.4 is a section through a pouring nozzle with integral upper changer plate for fixing in the bottom of a tundish to form the upper part of a pouring assembly provided in accordance with this invention;

Fig.5 is a section through a pouring component (SES) with integral lower slide changer plate for presentation to a corresponding upper plate in an upper part of a pouring assembly provided in accordance with this invention; and

Fig. 6 is a section through a pouring component (SES) similar in function to that of Fig. 5 but comprising an annular co-pressed enhanced-characteristic material within a conventional alumina graphite body having a conventional zirconia slag-wear-resisting band.

Example 1.

Referring to Fig. 3 of the drawing a refractory pouring body (1) having a throughbore (2), for use with a tube changing mechanism to provide a replaceable means for pouring of molten metal during continuous casting from a tundish into a casting mould, is isostatically pressed from powder refractory materials and binders selected to impart heat- and wear-resisting properties to the refractory one-piece composite body (1) which is formed by the isostatic pressing. The pressing operation to mould the refractory powder material is carried out in a manner generally known *per se* using a flexible mould to provide a shaped refractory body (1) having at one end of the body a flat plate surface (3) whilst the remainder of the body (1) is of generally cylindrical shape. Arbors and sacrificial void formers (if necessary) are inserted in the mould which is packed with the powder refractory/binder materials in order to provide in the pressed composite an axial throughbore (2) extending from an aperture (4) in the plate (3) to divergent outlets (5) at the tip (6) of the pouring body (1). By selecting

refractory materials from alumina graphite, zirconia graphite or magnesia graphite, using silicon-nitride (Si_3N_4) or silicon oxy-nitride (Si_2ON_2) as binder, with appropriate filling and packing of the mould it is possible to ensure that the peripheral edge (3') around said aperture (4) provides an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the throughbore of the pouring assembly during pouring of molten metal therethrough and that the body (1) is formed of a thermal shock-resistant material. Since the embodiment under discussion is intended for use as a submerged entry nozzle a band (7) of wear-resistant refractory material such zirconia or high zirconia/graphite mix is provided in a manner known per se.

Further, the known means of preventing physical damage during handling by the tube changer, i.e. a protective metal can (8) is fitted after normal finishing of the refractory composite. These finishing steps may include fine grinding of the plate surface (3).

In use the tube changer handles the composite refractory in much the same way as for the known two part assembly, using the underside of the metal can (8) to receive thrust to locate and support the composite pouring tube for use beneath either the conventional two part upper changer plate and tundish nozzle or the new composite of this invention as will be described hereinbelow.

Example 2

Referring to Fig. 4 of the drawing a refractory pouring nozzle (21) for location in the well block (20) in the bottom of a tundish (19), has a throughbore (22) and an integrally formed plate surface (23) for use with a tube changing mechanism during continuous casting from a tundish into a casting mould is isostatically pressed from powder refractory materials and binders selected (as discussed hereinbefore) to impart heat- and wear-resisting properties to the refractory one-piece composite body (21) which is formed by the isostatic pressing. The pressing operation to

mould the refractory powder material is carried out in a manner generally known per se using a flexible mould to provide a shaped refractory body (21) having at one end of the body a flat plate surface (23) whilst the remainder of the body (21) is optionally of tapered or cylindrical shape. Arbors and sacrificial void formers (if necessary) are inserted in the mould which is packed with the powder refractory/binder materials in order to provide in the pressed composite an axial throughbore (22) extending from an aperture (24) in the plate (23) to inlet (25) having a shape adapted to provide a seating surface (26) for a stopper (not shown). By selecting refractory materials from alumina graphite, zirconia graphite or magnesia graphite, bonded using silicon nitride or silicon oxy-nitride, with appropriate filling and packing of the mould it is possible to ensure that the peripheral edge (23') around said aperture (24) provides an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the throughbore of the pouring assembly during pouring of molten metal therethrough whilst the body (21) may be optionally formed of a thermal shock-resistant material. Normal finishing of the refractory which may include fine grinding of the plate surface (23) is carried out.

Example 3

A further embodiment of the invention is shown in Fig.5 of the drawings. In this case a submerged entry shroud (SES) is shown and it is formed in a manner generally equivalent to that described in Example 1 to provide a refractory pouring body (31) with a throughbore (32) and at one end of the body (31) a flat plate surface (33) whilst the remainder of the body (31) is of generally cylindrical shape for use with a tube changing mechanism as described before. Again by selecting appropriate refractory materials (as discussed hereinbefore) it is possible to ensure that the peripheral edge (33') around said aperture (34) provides an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the

throughbore of the pouring assembly during pouring of molten metal therethrough and that the body (31) is formed of a thermal shock-resistant material. Since the embodiment under discussion is intended for use as a submerged entry shroud a band (37) of wear-resistant refractory material such as zirconia or high zirconia/ graphite mix is provided in a manner known per se.
As before to prevent physical damage during changing a protective metal can (38) is fitted, and normal finishing of the refractory composite which may additionally include fine grinding of the plate surface (33) is carried out.

Example 4

As shown in Fig. 6 it is also possible to prepare the SES and outer plate region (43) from conventional alumina graphite material but to selectively enhance the region (43") around the aperture (44) in the plate surface (43) by an alternative material which at the same time exhibits the required mechanical strength, thermal shock resistance to operate as the "cutting edge" (43') during the tube change together with total compatibility with the physical properties of the remaining alumina/graphite body (41). In this embodiment the composition chosen includes 53% alumina, 18% silica, 24% zirconia and 3% carbon (as graphite) with the balance being minor amounts of typical materials used in this art. In other respects this embodiment is similar to that of Example 3 and parts thereof are numbered in an analogous fashion. Since this unit is manufactured in a single co-pressing step there is no risk of steel penetration at the interface.

The advantages of this invention are that the proposed pouring assembly by using upper and lower components of isostatically pressed graphitised alumina or graphitised alumina/zirconia mix or the like heat resisting, wear resisting ceramic materials produces a high integrity rigid system which completely eliminates two of the previous high

risk joints thereby reducing the disadvantages of gas leakage. This leads to less build up of alumina and choking of the pouring tubes. Another advantage lies in the improved control of the moveable system arising from the rigidity of the new system. Additionally by supplying a composite pouring body, there is a reduction of on-site assembly work which makes for improved quality control.

Claims

1. A refractory pouring-assembly component (1; 21; 31; 41) comprising an elongate tubular body having a throughbore (2; 22; 32; 42) for use with a tube changing mechanism to provide a replaceable means for pouring of molten metal during continuous casting from a tundish (19) into a mould characterised in that the refractory pouring component is an isostatically pressed, heat- and wear-resisting refractory one-piece composite body (1; 21; 31; 41) which is shaped to provide at one end a smooth, flat plate surface (3; 23; 33; 43) in which there is defined an aperture (4; 24; 34; 44), the peripheral edge (3'; 23'; 33'; 43') around said aperture being formed of a hard refractory material to provide an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the throughbore (2; 22; 32; 42) of the pouring assembly during pouring of molten metal therethrough, whilst the remainder of said body is formed to a tubular shape from a thermal shock-resistant material to provide for pouring of melt.

2. A refractory component according to claim 1 wherein the said component is formed from materials selected from alumina graphite, zirconia graphite, magnesia graphite or appropriate mixtures thereof which are silicon nitride-bonded or silicon oxy-nitride-bonded.

3. A refractory component according to claim 2 wherein the said materials are mixed such that said component has a substantially uniform composition.

4. A refractory component according to claim 1 wherein compatible refractory materials are selected and mixed to provide at least two compatible compositions which are co-pressed to form a composite body in which there is provided an annulus (43") around the aperture (44) in the flat plate surface (43) having a composition of said materials which provides the requisite strength and thermal shock resistance to provide said cutting edge (43') and exhibits physical

compatibility with the other composition(s) which make up said remaining plate and body.

5. A refractory component according to claim 4 wherein the composition of said annulus (43") comprises a mixture of alumina, silica, zirconia and graphite and said remaining plate and body composition comprises mainly alumina graphite.

6. A refractory component according to claim 4 or claim 5 wherein the composition of said annulus comprises 53% alumina, 18% silica, 24% zirconia and 3% graphite with the balance being minor amounts of typical refractory materials used in this art.

7. A refractory pouring-assembly component comprising an elongate tubular body having a throughbore for use with a tube changing mechanism to provide a replaceable means for pouring of molten metal during continuous casting from a tundish into a mould wherein the refractory pouring component is an isostatically pressed, heat- and wear-resisting refractory one-piece composite body which is shaped to provide at one end a smooth, flat plate surface in which there is defined an aperture, the peripheral edge around said aperture being formed of a hard refractory material to provide an edge which during a tube changing operation is capable of cutting a skin or shell of solidified melt formed within the throughbore of the pouring assembly during pouring of molten metal therethrough, whilst the remainder of said body is formed to a tubular shape from a thermal shock-resistant material to provide for pouring of melt.

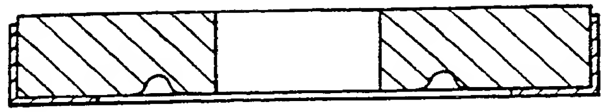


Fig. 1

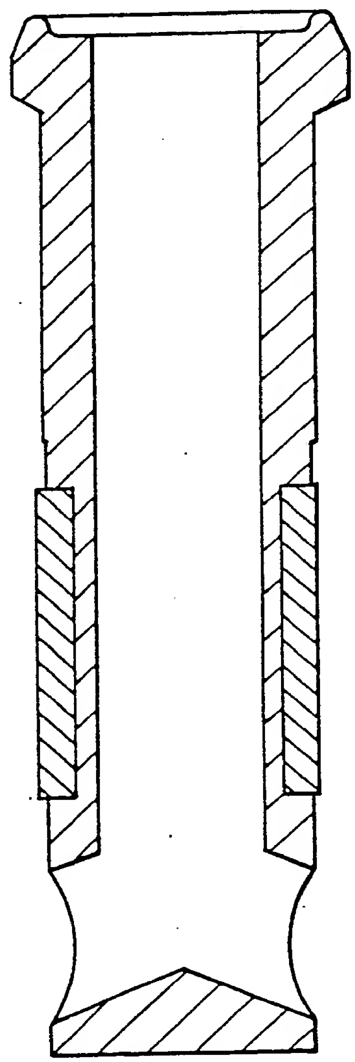


Fig. 2

SUBSTITUTE SHEET

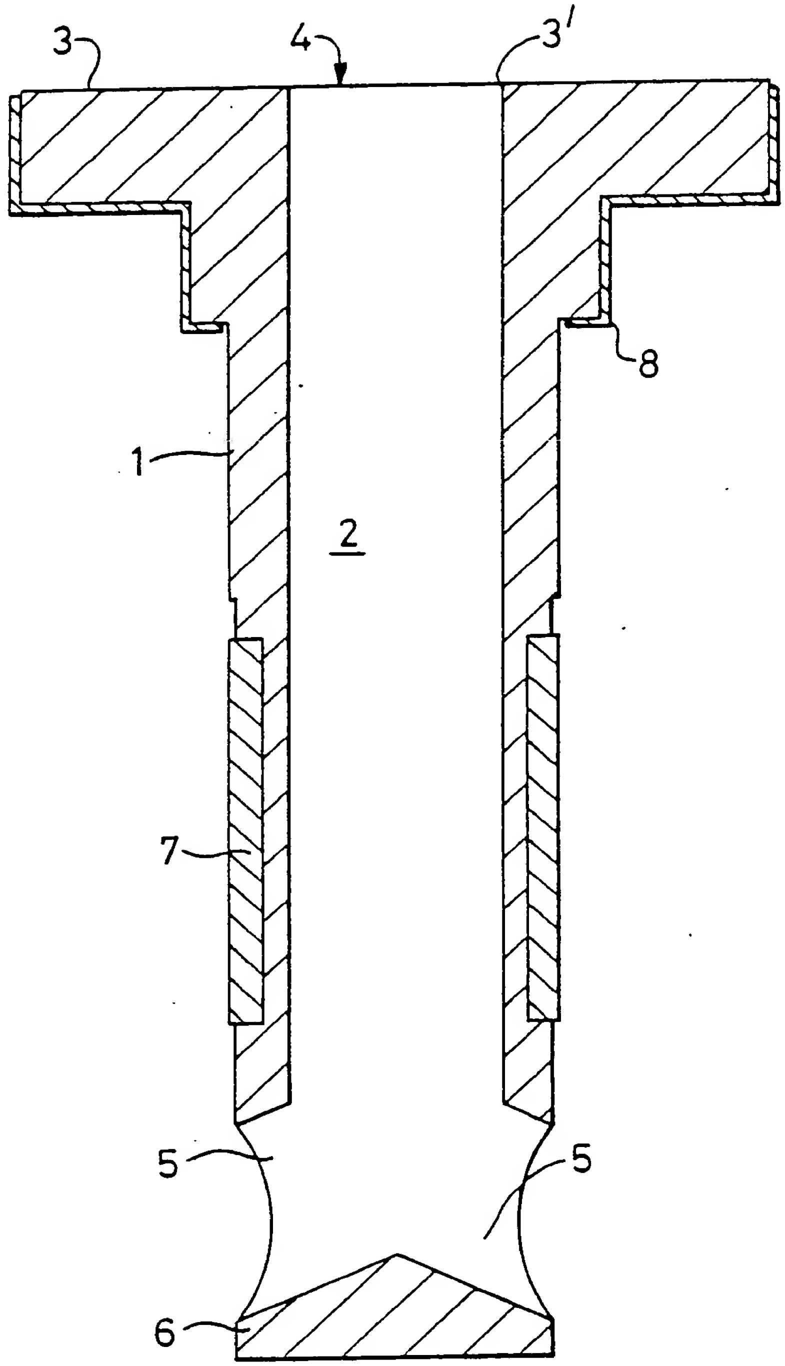


Fig. 3

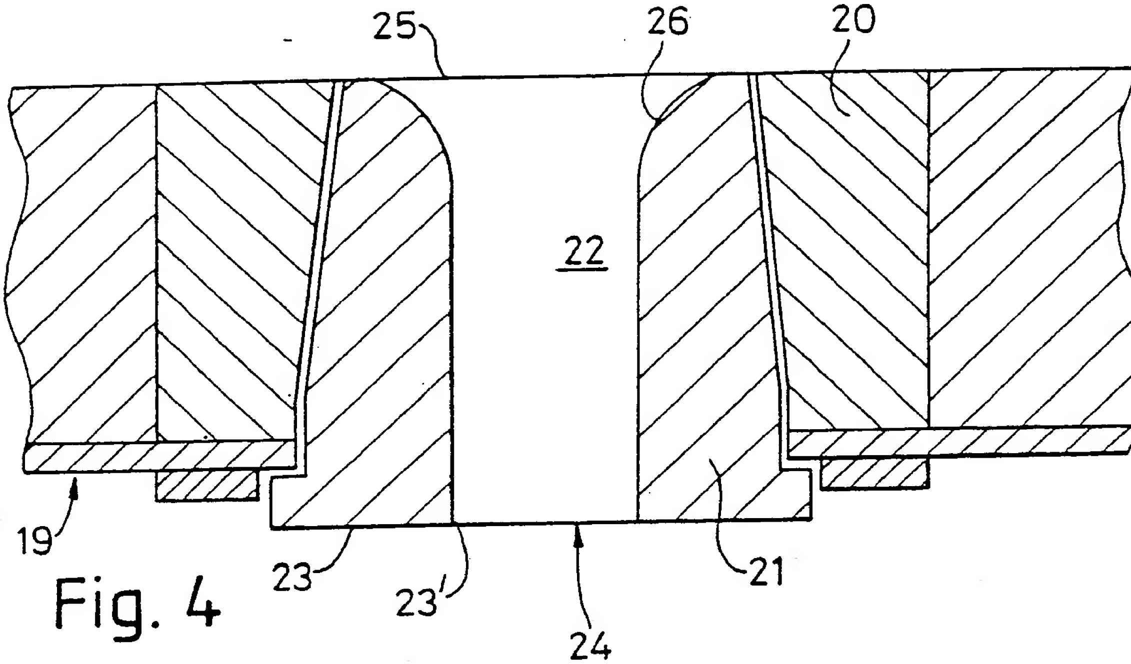


Fig. 4

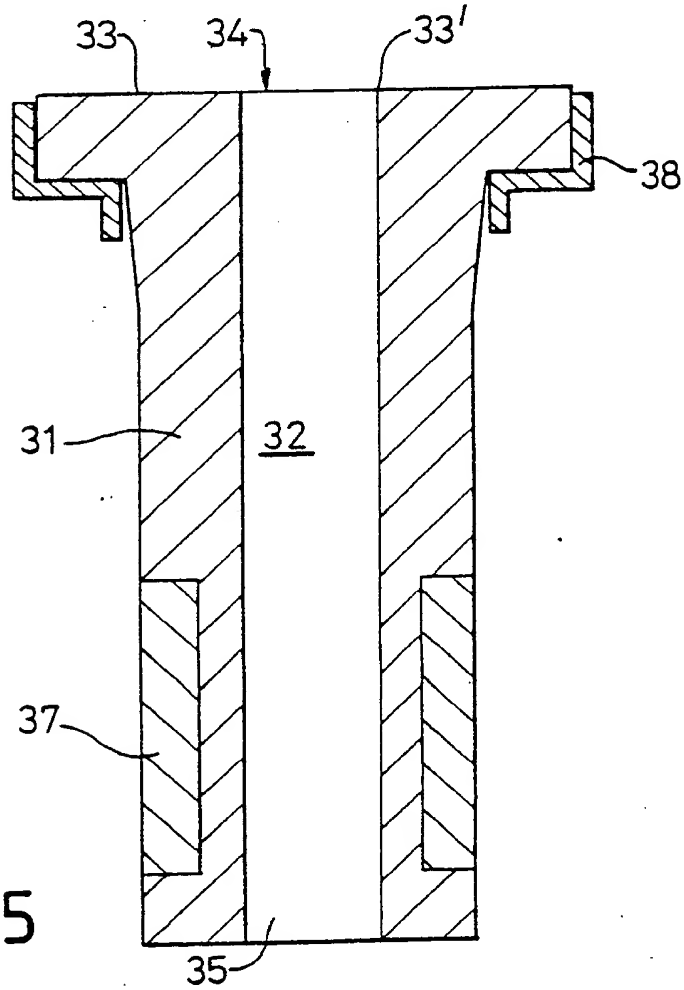


Fig. 5

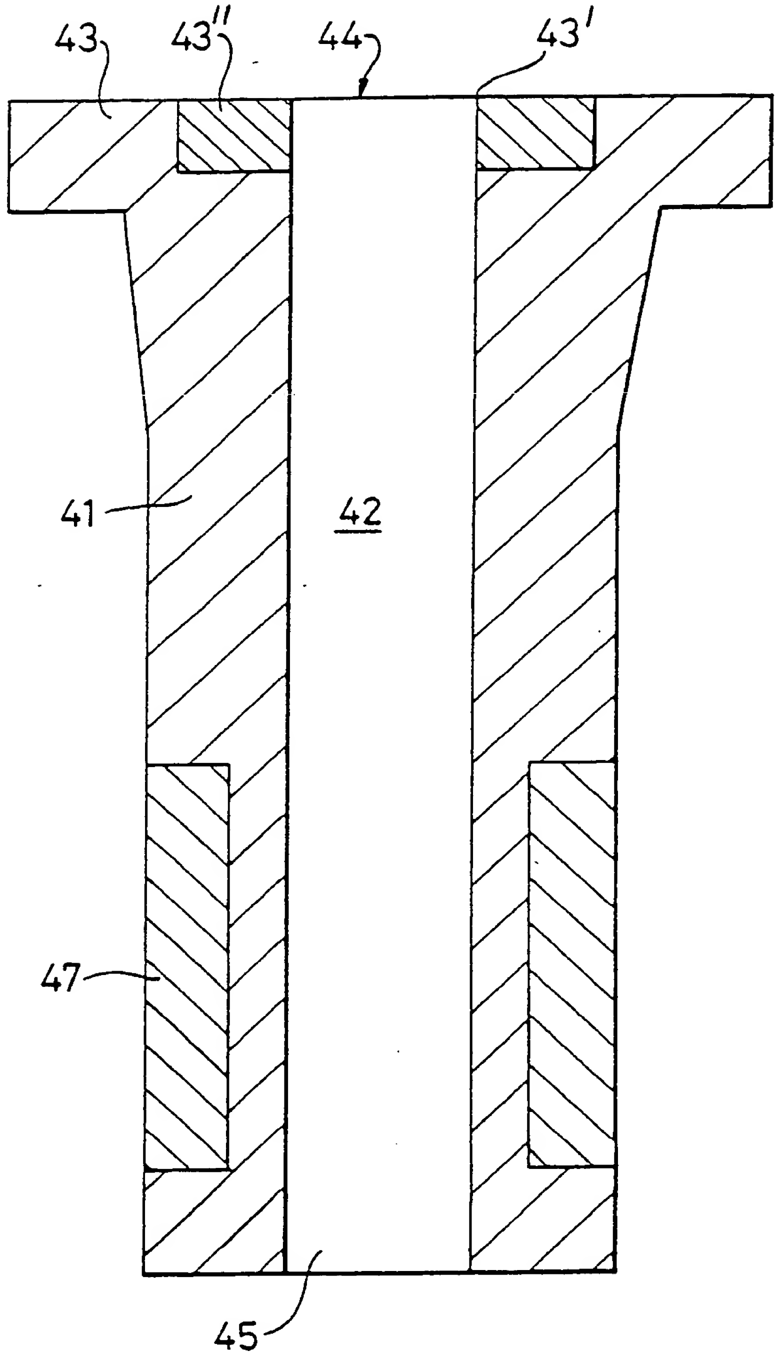


Fig. 6

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00139

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 22 D 11/10; B 22 D 41/08

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 22 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [*]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	FR, A, 2388621 (DIDIER-WERKE) 24 November 1978 see page 3, line 25 - page 5, line 33	1,3,4,7
X	US, A, 4108675 (NIPPON KOKAN K.K.) 22 August 1978 see column 2, line 55 - column 5, line 10	1-3,7
A	FR, A, 2347133 (DIDIER-WERKE) 4 November 1977 see page 4, line 1 - page 5, line 14	1
A	DE, A, 2816283 (USS ENGINEERS) 26 October 1978 see figures 1,3c,5; page 14, line 1 - page 16, line 27	1
A	Patent Abstracts of Japan, volume 5, no. 61 (M-65)(733), 24 April 1981, & JP, A, 5614060 (KUROSAKI YOUGIYOU K.K.) 10 February 1981	6

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
30th May 1988	2 9 JUIN 1988
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8800139. SA 20944

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 15/06/88
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR-A- 2388621	24-11-78	BE-A- 866390	14-08-78
		DE-A,B,C 2719105	09-11-78
		JP-A- 53135831	27-11-78
		US-A- 4179046	18-12-79
		CA-A- 1089180	11-11-80
		GB-A- 1588700	29-04-81
		SE-A- 7804188	30-10-78
		SE-C- 435462	10-01-85
		AT-B- 383975	10-09-87
US-A- 4108675	22-08-78	BE-A- 837916	14-05-76
		LU-A- 74254	23-07-76
		FR-A,B 2299106	27-08-76
		DE-A,B 2603342	05-08-76
		GB-A- 1483323	17-08-77
		AU-A- 1042076	28-07-77
		AU-B- 497618	21-12-78
		JP-A- 51087131	30-07-76
FR-A- 2347133	04-11-77	BE-A- 853408	01-08-77
		DE-A,C 2615537	28-07-77
		AT-B- 351192	10-07-79
		JP-A- 52129633	31-10-77
		GB-A- 1576778	15-10-80
DE-A- 2816283	26-10-78	JP-A- 54009022	23-01-79

EPO FORM P0479

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82